A Web-based Library of Marine Animal Sounds

Jack W. Bradbury

Cornell University; Macaulay Library, Cornell Laboratory of Ornithology, 159 Sapsucker Woods Rd., Ithaca, NY 14850

Jwb25@cornell.edu

With funding from ONR and DURIP, the Macaulay Library at the Cornell University Laboratory of Ornithology has begun the creation of an Internet-accessible centralized archive of marine animal sounds. In addition to complex search and online editing tools, the facility will provide a number of analytical tools for identification, comparison, and measurement of digital sound files. The presentation will outline the state of the system at the time of the conference. Initial holdings should be online by Fall, 2003.

Dynamics of the Hawaiian Mesopelagic Boundary Community and Their Effects on Predator Foraging

(1) Whitlow W. Au
(2) Kelly J. Benoit-Bird

(1-2) Hawaii Institute of Marine Biology; PO Box 1106, Kailua, HI 96734

(1) Wau@hawaii.edu

In the Hawaiian Islands, a distinct, resident community of micronekton is distributed over the underwater slopes of the islands. We used an echosounder to simultaneously measure the abundance of spinner dolphins and the mesopelagic boundary community to investigate the spatial and temporal dynamics of the prey and their impact on the foraging behavior of spinner dolphins. Mesopelagic animals were heterogeneously distributed and underwent a diel horizontal migration in addition to their vertical migration. Because of this horizontal movement, the highest densities of mesopelagic animals, reaching up to 1800 animals/m^3, were observed nearshore. A series of sonar moorings measured the layer's vertical migration rate between 0 and 1.7 m/min and average an horizontal rate of 1.67 km/hr. Spinner dolphins followed the migration patterns of their prey both horizontally and vertically. Overlap was observed between spinner dolphins and their prey at temporal scales ranging from several minutes to an entire night and at spatial scales of 20 meters to several kilometers. An understanding of the spatial and temporal dynamics of the mesopelagic boundary community permitted the accurate prediction of spinner dolphin movement patterns and an increased understanding of their behavior.

Using Active Sonar to Detect Marine Mammals

(1) Peter J. Stein
(2) Michael Birmann
(3) Jason Rudzinsky

(1-3) Scientific Solutions Inc.; 99 Perimeter Rd., Nashua, NH 03063

(1) Pstein@scisol.com

Underwater acoustic risk mitigation policies often require that at-sea operation planners make all efforts, including cessation of operations, to avoid exposing any marine mammal to sound pressure levels in excess of some specified value. As received level is predominantly a function of range and source level, these policies effectively designate a "marine mammal free" zone around the sound-source. Considering that visual based monitoring surveys are not effective in poor weather, and low-light and that passive detection of marine mammals is not useful when animals choose not to vocalize, we here present the benefits and challenges of using low power active sonars (i.e., echolocation systems) designed specifically to detect marine mammals. Two such systems are discussed - the High Frequency Marine Mammal Monitoring (HFM3) system and the Integrated Marine Mammal Monitoring and Protection System (IMAPS). Discussion of these systems will include design rationales and tradeoffs along with the challenges and importance of testing and evaluating system performance.

Deployment scenarios and the potential for reducing the operational sacrifices that are routinely made by the seismic, military and scientific communities to satisfy regulatory constraints will also be presented.

Acoustic Detection of Manatee Vocalizations

(1) Christopher Niezrecki
(2) Richard Phillips
(3) Michael Meyer
(4) Diedrich O. Beusse

(1-3) University of Florida; Department of Mechanical and Aerospace Engineering, 231 Aerospace Building, PO Box 116250, Gainesville, Florida 32611-6250
(4) University of Florida; Department of Small Animal Clinical Services, College of Veterinary Medicine, PO Box 100126, Gainesville, FL 32610-0126

(1) Niezreck@ufl.edu

The West Indian manatee (*trichechus manatus latirostris*) has become endangered partly because of a growing number of collisions with boats. A system to warn boaters of the presence of manatees, that can signal to boaters that manatees are present in the immediate vicinity, could potentially reduce these boat collisions. In order to identify the presence of manatees, acoustic methods are employed. Within this work, three different detection algorithms are used to detect the calls of the West Indian manatee. The detection systems are tested in the Laboratory using simulated manatee vocalizations from an audio compact disc. The detection method that provides the best overall performance is able to correctly identify ~96% of the manatee vocalizations. However the system also results in a false positive rate of ~16%. The results of this work may ultimately lead to the development of a manatee warning system that can warn boaters of the presence of manatees.

Project Humpback- A Radar-Based, Humpback Detection and Tracking Experiment

(1) Douglas F. DeProspo
(2) Joseph Mobley
(3) Charles Forsyth
(4) Clayton Chinn
(5) Wai Hom
(6) Averiet Soto

(1-6) Arete Associates; 1725 Jefferson Davis Hwy., Suite 703, Arlington, VA 22202

(1) Deprospo@arete-dc.com

In this paper, we report on the results of an ONR-sponsored, extensive radar-based Humpback detection and tracking experiment conducted at the Pacific Missile Range Facility. The goal of this experiment, called Project Humpback, was to validate prior theoretical calculations which suggested that Humpbacks could be detected and tracked at long standoffs (> 5 km.) at grazing angles consistent with ship-based and aircraft-based radar-mammal encounters.

AINS-SWARM UAV for Marine Mammal Detection

(1) Anthony C. Mulligan
(2) Ellen Livingston
(3) John Williams

(1) Advanced Ceramics Research, Inc.; 3292 E. Hemisphere Loop, Tucson, AZ 85706
(2-3) Office of Naval Research; Ballston Tower One, 800 N. Quincy St., Arlington, VA 22217-5660

(1) Amulliga@acrtucson.com

In an ongoing funded ONR STTR Phase II program, ACR has developed a new generation low cost small UAV called the AINS-SWARM. The AINS-SWARM concept has been developed in relation to operational parameters for use in Marine Mammal Detection missions for the

Navy. In addition, ONR has sponsored incorporation of numerous user friendly flight software routines developed under the Autonomous Intelligent Network of Systems Program (AINS). In addition, ONR funding will provide a dedicated one-year effort for evaluating SWARM performance for marine mammal detection at the Navy`s Pacific Missile Range Facility in Hawaii. This program will also operate as a test bed for a wide variety of new ONR sponsored state-of-the-art sensors, including SAR, IR, FLIR, Acoustic, Magnetic, and others under development by the navy and other military developers.

Effect of Fish (?) Choruses and Recreational Boats on the Spatial Structure and Temporal Dependence of the Ocean`s Mid-Frequency (1 kHz-10 kHz) Noise Field

(1) Gerald L. D`Spain
(2) Heidi Batchelor
(3) Lewis Berger

(1-3) Scripps Institution of Oceanography; Marine Physical Laboratory, 291 Rosecrans St., San Diego, CA 92122

(1) Gld@mpl.ucsd.edu

The prevailing sources of ocean ambient noise at mid-frequencies (MF) are associated with wind-generated ocean surface waves. Local ships and marine animals also contribute at certain times and locations. This presentation summarizes the major features in shallow water ocean noise measurements made by the Marine Physical Laboratory's 131-hydrophone, 2D billboard array. The main part of the array is composed of four vertical staves of 32 elements each, all with interelement spacing equal to half-wavelength at 3.75 kHz. Eight days of data were collected in July, 2002 in 175-m water located 2 km from the ``43-Fathom Spot``, a popular fishing area in Southern California. Small boats often made significant contributions to the MF noise field. In addition, a striking difference exists in the vertical spatial structure of ambient noise between daytime and nightime periods. During the day, a noise notch almost always exists in the horizontal, with levels more than 10 dB below those in more vertical directions. The pattern reverses at night - horizontal noise levels often exceed higher angle levels. The directions of arrival of this horizontally propagating energy occur towards the 43-Fathom Spot and may represent a nighttime fish chorusing behavior. [Work supported by ONR, Code 321(US)].

MANTA: The Marine Animal Tracking Apparatus

(1) Thomas F. Norris
(2) Marco Flagg

(1) Science Applications International Corp.; 3990 Old Town Ave., Suite 208A, San Diego, CA 92120
(2) Desert Star Systems Inc.; 761 Neeson Rd., Suite 9, Marina, CA 93933

(1) Thomas.f.norris@saic.com

MANTA is a tracking and data-telemetry system that integrates acoustic transponder, underwater modem, data-logging, and VHF tracking technologies. The MANTA system is not intended to replace or supercede existing animal data-logging acoustic or radio-telemetry systems. Rather, it will significantly expand tagging and tracking capabilities. Its primary application is for detailed underwater tracking and data telemetry of large marine vertebrates (e.g. whales, elasmobranchs, pinnipeds, sea turtles etc.). By integrating several complementary technologies, it is possible to track tagged marine animals in real-time, three-dimensionally, and at very high spatial resolution. Location information that is recorded in real-time on a "surface station" includes the animal's latitude, longitude, and depth. Data can be collected from up to 6 sensors (e.g. accelerometer, thermistor, etc.) onboard the tag, and telemetered to the surface via an underwater acoustic modem, or logged internally on scalable memory modules. Using the MANTA system we plan to collect detailed information on orientations, movement patterns, vocalization rates, and other detailed behaviors of marine vertebrates to investigate interactions with their environment. We will present examples of data collected from a single test deployment on a wild manta ray and discuss plans to tag marine mammals and turtles this summer.

Passive Detection and Localization of Transient Marine Mammal Calls using Widely Spaced Bottom Mounted Hydrophones in Open Ocean Environments

(1) Susan M. Jarvis
(2) Nancy DiMarzio
(3) Ronald Morrissey
(4) David Moretti

(1-4) NUWC; 1176 Howell St., Bldg. 1351, Newport, RI 02841

(1) JarvisSM@npt.nuwc.navy.mil

The Office of Naval Research Marine Mammal Monitoring on Navy Ranges (M3R) project has developed a toolset for passive detection and localization of marine mammals using the existing infrastructure of Navy undersea ranges. The tools are designed to work across a broad class of calls including clicks, sweeps, and whistles. They allow the real-time detection and localization of marine mammals using widely spaced omni-directional hydrophones. A broadband signal detection algorithm, data association algorithm, and tracking algorithm have been developed and demonstrated. This paper will present the passive acoustic monitoring and localization tools developed under M3R. It will also present results of the application of these tools to the real-time detection and tracking of various toothed whale species at the Atlantic Undersea Test and Evaluation Center (AUTEC), Andros Island, Bahamas. Future plans for a deployable marine mammal tracking system including the use of GPS modified sonobuoys will be discussed.

Assessing the Performance of Omni-directional Receivers for Passive Acoustic Detection of Vocalizing Odontocetes

(1) John M. Daziens
(2) Jorge F. Garcia
(3) Ching-Sang Chiu
(4) Curtis A. Collins
(5) Christopher W. Miller

(1-5) Naval Postgraduate School; 1 University Circle, Monterey, CA 93943

(1) Jmdazien@nps.navy.mil

Acoustic detection and localization of marine mammals will assist mitigation efforts for various Naval and scientific missions that may impact protected species. This study seeks to experimentally quantify the sonar performance of simple, omni-directional receivers as a means to passively detect vocalizing Odontocetes in coastal waters. To accomplish this objective, controlled experiments using a calibrated mid-frequency sound source were conducted on the San Clemente Island Underwater Range (SCIUR) in July 2002. Six odontoceti signals were selected for transmission based upon availability and quality of archived recordings: 2 orca whistles, 2 pilot whistles, Sperm whale click, and Risso dolphin click. Over a period of three days, several hundred iterations of each signal were broadcast from R/V Point Sur at prescribed locations with ranges varying from 300 m to 12,000 m from a stationary underwater array consisting of three vertically distributed hydrophones. Statistical analyses were performed on the output of an energy and correlation detector to quantify detection probability and range limits as a function of false alarm rate, signal type, and signal to noise ratio/environmental condition.

The Application of Multi-Sensor, Multi-Hypothesis Tracker to Localization and Tracking of Cetaceans

Arthur M. Teranishi

ORINCON Corporation; 4770 Eastgate Mall, San Diego, CA 92121

Art@orincon.com

In recent years, the anti-submarine warfare (ASW) and seismic survey communities have become increasingly aware of the potential harmful effects of active sonar transmissions on marine mammals. Current mitigation requirements require marine mammals to be outside of the transmission area where receive levels are greater than 160dB re 1 micropascal at 1 meter. To aid in detecting these animals within this area, both acoustic and non-acoustic methods are under development. On an ONR funded project, multiple DIFAR sonobuoy arrays are used to detect marine mammals. The information collected from these sonobuoys is employed by a multi-sensor, multi-hypothesis tracker to localize and track acoustically active marine mammals.

The multi-sensor, multi-hypothesis tracker (MHT) is a software application developed to correlate data from multiple dissimilar sensors over time. Developed under various Navy and DARPA programs, the MHT has been applied to ASW and other military applications since the 1970's. Currently, the MHT is used to fuse information from various sensor systems including passive and active sonar systems and radar systems. The MHT uses a predict and update mechanism based on an extended Kalman filter to correlate tracks to sensor detections.

A Comparative Study of the Effectiveness of Visual and Acoustic Monitoring Methods

(1) Peter D. Ward
(2) Peter Varley

(1) QinetiQ; Southampton Oceanography Centre, European Way, Southampton, SO14 3ZH United Kingdom
(2) Element Ltd.; Gosport, United Kingdom

(1) Peter.ward@soc.soton.ac.uk

The primary environmental concern relating to underwater sound sources, is the potential for marine mammals in close proximity to the sound source to suffer hearing damage or some degree of acoustic disturbance. In order to implement effective mitigation, the position of the animals, relative to the sound source, must be determined as accurately as possible. At present, marine mammal monitoring is conducted primarily by visual observers, supplemented by passive acoustics to detect vocalising animals. Visual monitoring can lead to the detection, classification and localisation of the animals but requires alert, trained and well motivated observers as well as generally good observing conditions. Monitoring using passive sonar relies upon the animals vocalising, which is species and context specific, while subsequent localisation can be problematic. This paper assesses the effectiveness of both techniques used in isolation, as well as in combination with each other. A Measure of Effectiveness (MoE) has been defined and, using a probabilistic approach, takes into account the individual components that make up the MoE for each technique. Values for the MoE have been estimated for visual monitoring and passive acoustic monitoring using typical generic sonar systems. This is followed by a discussion of the implications of the results for effective marine mammal monitoring.

Marine Mammal Detection and Mitigation

(1) Gary M. Donoher
(2) Andrew J. Read
(3) Alan Sassler
(4) William A.Watkins

(1) Analysis, Design & Diagnostics, Inc.; 317 West Forsyth St., Jacksonville, FL 32202-4307
(2) Duke University; Marine Laboratory, 135 Duke Marine Laboratory Rd., Beaufort, NC 28516
(3) Advanced Acoustic Concepts, Inc.; Las Vegas, NV
(4) Woods Hole Oceanographic Institution; Mailstop 36, Woods Hole, MA 02543

(1) Gdonoher@addinc.org

Analysis, Design & Diagnostics, Inc. has teamed with Advanced Acoustic Concepts, Duke University and Woods Hole Oceanographic Institution to provide the United States Navy a near-term solution for Marine Mammal Detection and Mitigation (MMDM) for both surface ship and aircraft platforms. The team's approach is environmentally friendly and exploits marine mammal vocalizations. We have identified sensors currently used by the U.S. Navy that have sufficient bandwidth to detect most marine mammal vocalizations and are using ground-truthed recordings to develop our detectors. "Real-world" acoustic recordings (littoral and blue water) from current fleet sensors are used to test and evaluate the performance of the detectors in operational environments. Once detected and classified as a marine mammal vocalization, several methods are used to localize the emitter. For low frequency vocalizations, colored DIFAR techniques are used to determine range and bearing to the source. For higher frequency vocalizations, and when detected on multiple sensors, hyperbolic fixing (HYFIX) techniques are employed to localize the emitter. Using these techniques, the Navy can obtain a verifiable record of marine mammal distribution for future MMDM. Additionally, this will provide the Office of Naval Research a means to better understand the distribution and relative abundance of marine mammals.

Temporal Patterns in Visual and Acoustic Detection Rates of Blue Whales in the Southern California Bight

(1) Erin Oleson
(2) John Calambokidis
(3) Sean Wiggins
(4) Mark McDoanld
(5) John Hildebrand

(1,3,5) Scripps Institution of Oceanography; 9500 Gilman Dr. #0205, La Jolla, CA 92093
(2) Cascadia Research Collective; 218 1/2 W 4th Ave., Olympia, WA 98501
(4) Whale Acoustics; 11430 Rist Canyon Road, Bellvue, CO 80512

(1) Eoleson@ucsd.edu

Using a suite of visual and acoustic assessment methods, including seafloor acoustic recording packages (ARPs), sonobuoys, ship and aerial surveys, we have measured the changes in seasonal and diurnal blue whale calling, and have compared it with sighting rates from visual surveys. ARPs at Cortez/Tanner Banks have been recording since August, 2000 providing a detailed record of calling presence for over 2.5 years, with nearly 400,000 type B calls recorded to date. Blue whale B calls are detected May-January, with a peak in call counts (1400 calls/day/site) in September. Continuous ARP data also indicate a diurnal pattern of call detection, with 30% more B calls near sunrise and sunset than the reminder of the day. Type D calls are less numerous without a significant seasonal peak between June and December. These observations are supported by opportunistic sonobuoy deployments during ship surveys in June-October of 2000-2002. The sighting rate for blue whales from ship surveys was nearly equal between June and August; however, there was a higher rate of visual versus acoustic detection in June compared to August. Concurrent visual and acoustic observations of blue whales indicate that the detection of D calls more closely matches sighting rates, while B calls are more abundant late in the season, suggesting seasonal variation in the proportion of animals producing B calls.

Tools for Monitoring Marine Mammals

(1) Thomas Calupca
(2) Christopher W. Clark
(3) Kathy Dunsmore
(4) Thomas Fowler
(5) Kurt Fristrup
(6) Robert MacCurdy
(7) Harold Mills
(8) Alejandro Purgue
(9) Amanda Waak

(1-9) Cornell Laboratory of Ornithology; 159 Sapsucker Woods Rd., Ithaca, NY 14850

(1) Calupca@cornell.edu

Mechanisms for monitoring the behaviors and movements of free-ranging whales were developed and implemented. Passive acoustic systems include autonomous seafloor recorders, towed arrays, and sparse VHF arrays. Software systems include programs for acoustic data exploration, and automatic detection and location. Single autonomous seafloor recorders ("pop-ups") allowed sampling in remote areas for rare or difficult to record species for periods of months, while also providing data on ambient noise conditions. Sets of pop-ups were deployed and synchronized to form arrays. Pop-up array data combined with customized software, provided detailed information on the number, distribution, and movement of individual, vocal animals. Towed arrays allowed real-time beamforming and tracking of individuals, while sparse VHF arrays allow real-time localization and tracking of individuals. When integrated with other methods (e.g., visual survey, tagging, oceanographic sampling), these acoustic tools yielded valuable measures of behaviors under a variety of acoustic exposure conditions.

Software Tools for Bioacoustic Analysis

(1) David K. Mellinger
(2) Christopher G. Fox

(1) Oregon State University; 2030 SE Marine Science Dr., Newport, OR 97365
(2) National Oceanographic and Atmospheric Administration; Pacific Marine Environmental Laboratory, 2115 SE OSU Dr., Newport, OR 97365

(1) Mellinger@pmel.noaa.gov

A number of software tools are presented that have been developed and used for marine mammal acoustic study. Foremost among these is Ishmael, a Windows program for collecting, storing, and analyzing sound, especially real-time data and/or large recorded archives. It can acquire and record multi-channel real-time hydrophone signals, or read from pre-recorded sound files. It displays incoming sound in real time as waveforms and spectrograms. It can perform acoustic localization and tracking by any of three methods. It does automatic call recognition by three different methods; detected sounds can be logged, or automatically extracted and saved to disk. Ishmael has been used extensively in both field and Laboratory: on Navy test cruises off the Atlantic seaboard; on NMFS dolphin abundance surveys; on Gulf of Mexico sperm whale studies; and for detection of right whales in the Gulf of Alaska.

Other tools include ishDifar, an Ishmael extension for analyzing and displaying DIFAR (directional) sonobuoy data; Osprey, a spectrogram viewer targeted at exploratory analysis and measurement of pre-recorded sound files; AcousticLocation, a toolbox for calculating locations of sound sources using time-of-arrival differences; and ConvertSoundFile, a utility for converting sound file formats and sampling rates.

These packages are all freely available at http://cetus.pmel.noaa.gov/cgi-bin/MobySoft.pl.

Passive Acoustics for ARMP: Hardware and Software Tools

(1) Gianni Pavan
(2) M.Manghi
(3) C.Fossati
(4) M.Priano

(1-4) Centro Interdisciplinare di Bioacustica e Ricerche; Via Taramelli 24, Pavia, 27100 Italy

(1) Gpavan@cibra.unipv.it

Since 1999 CIBRA co-operates with NATO SACLANTCEN within SOLMaR project (Sound, Oceanography and Living Marine Resources). The project is aimed at developing Acoustic Risk Mitigation Policies (ARMP) for NATO's Navies and at characterizing and testing the required tools. To support these aims, software and hardware have converged to a workstation, designed, assembled and tested, during four Sirena research cruises, to provide wide-band underwater acoustic monitoring. The current configuration includes a simple towed array with assorted acoustic sensors, ranging from audio to ~300kHz, connected to a PC based workstation, running custom software to deliver 8-channels high resolution wide-band real-time spectrographic display. The standard bandwidth is 48 kHz per channel, expandable up to 200 kHz on single channels.

If connected to a suitable array, the system already offers wideband beamforming, while single channels can be linked to sensors offering multiple views of the environment. Signals can be continuously recorded on large disk arrays, and then organized in automatically georeferenced cuts. Acoustic events, recognized and categorized by operators, flow to a GIS for real-time mapping. Passive acoustic detection capabilities in the most sensitive range for ARMP are maximized. Maps of acoustic contacts in three Sirena cruises will be presented and discussed.

The project is carried out within the NATO Saclantcent's SOLMAR Project with ONR Grants N00014-99-1-0709 and N00014-02-1-0333.

The Efficacy of Passive Acoustics for the Detection and Localization of Marine Mammals as Compared to a Visual Aerial Survey

(1) David J. Moretti
(2) Susan Jarvis
(3) Nancy DiMarzio
(4) Ron Morrissey
(5) Joseph Mobley

(1) NAVSEA Undersea Warfare Center; Bldg. 1351, Code 71, Newport, RI 02879
(2-4) Naval Undersea Warfare Center, Division Newport; Engineering, Test and Evaluation Department, 1176 Howell St., Newport, RI 02841-1708
(5) Marine Mammal Research Consultants, Ltd.; 801 S. King St, Suite 3108, Honolulu, HI 96813

(1) D.j.moretti@ieee.org

The Office of Naval Research Marine Mammal Monitoring on Navy Ranges (M3R) program has developed passive acoustic marine mammal monitoring tools. The efficacy of these tools was compared to the results of visual aerial surveys. A test was conducted on the Atlantic Undersea Test and Evaluation Center (AUTEC) acoustic range using broadband bottom-mounted hydrophones. Multiple coordinated passive acoustic and aerial surveys were conducted between January 4 -12, 2003. The results of both surveys will be presented and compared. The strengths and weaknesses of both techniques will be discussed.

Passive Acoustic Marine Mammal Monitoring at a Navy Instrumented Test Range

Stephen W. Martin
Joseph Mobley Jr.

(1) SPAWAR Systems Center - San Diego; 53560 Hull St., Code 2374, San Diego, CA 92152
(2) University of Hawaii West Oahu; 96-129 Aka Ike, Pearl City, HI 96782

Martinsw@spawar.navy.mil

A Navy instrumented test range, on Kauai, Hawaii, has been acoustically monitored, on selected days, over the past year. The ranges twenty four broadband hydrophones were continuously monitored preserving bandwidths up to 22 KHz. Dates of the monitoring were selected to coincide with trusted aerial surveys being conducted by Dr. Joseph Mobley, of the University of Hawaii. Eight of the aerial surveys were conducted in support of the North Pacific Acoustic Laboratory program in February and March of 2002. Ten additional surveys were conducted between July and November of 2002. Both survey efforts (acoustic and aerial) are continuing in 2003.

The data collection process will be described, as well as, initial efforts to look at acoustic call statistics as related to aerial survey sighting statistics. A long-term goal of this effort is to potentially improve future population estimates by utilizing acoustic survey information to supplement aerial survey information.

Automated Model-based Passive Acoustic Tracking of Marine Mammals

(1) Christopher O. Tiemann
(2) Michael B. Porter

(1-2) Science Applications International Corp.; 10260 Campus Point Dr., MS C-3, San Diego, CA 92121

(1) Tiemannc@saic.com

A key way to reduce the effect of sound on marine mammals is simply to reduce power levels when mammals are present. In this application, passive techniques that track animals based on their own calls obviously have an intrinsic advantage over active methods that introduce additional sound into the environment. An algorithm for passively locating singing marine mammals has been successfully tested against real acoustic data from three different environments (Hawaii, California, and Bahamas) and three different species (humpback, blue, and sperm whales). The technique is novel in its use of an acoustic propagation model to predict time-differences of arrival (time-lags) of a call heard on widely-spaced receiver pairs. Comparing modeled and measured time-lags forms an ambiguity surface, or visual representation of the most likely whale position. Since it uses an acoustic propagation model, the algorithm is not limited to the straight-line acoustic path assumptions of traditional hyperbolic fixing techniques. It has also been highly optimized so that it can be readily used in real-time monitoring applications without any user interaction. Besides the examples with real data, we will also demonstrate the accuracy of the technique using data from a controlled source test with known position.